

U.S. Patent Application Serial No. 10/821,059
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.915.6494
Attorney Docket No. J4083/399978
REPLACEMENT DRAWING

BEST AVAILABLE COPY

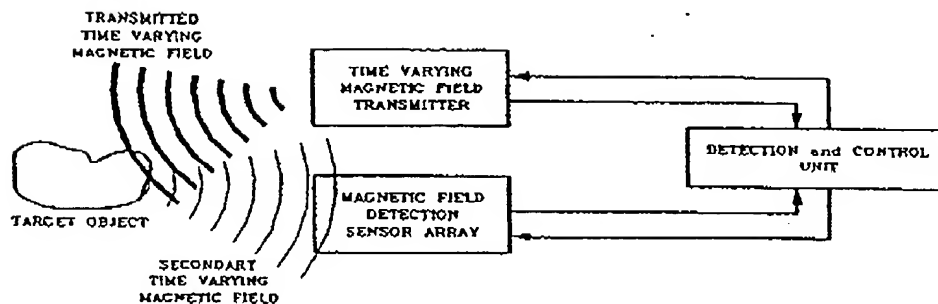


FIGURE 1-1 SYSTEM BLOCK DIAGRAM

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494.
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

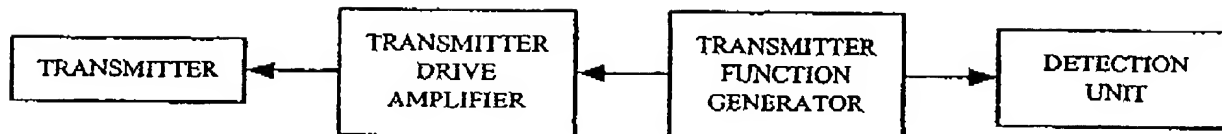


FIGURE 1-2
TRANSMITTER WITH KNOWN OUTPUT FUNCTION

Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

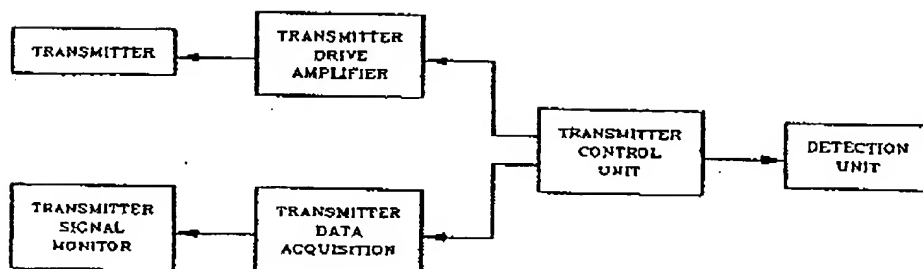


FIGURE 1-3
TRANSMITTER WITH MAGNETIC FIELD MONITOR

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

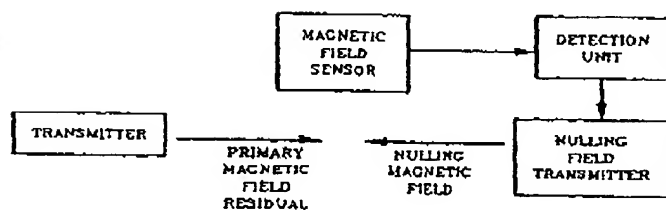


FIGURE 1-4A
RESIDUAL MAGNETIC FIELD NULLING
USING A NULLING MAGNETIC FIELD

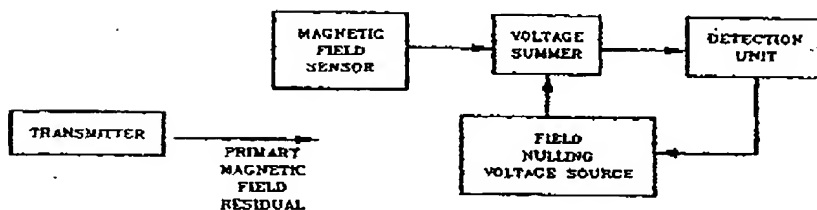


FIGURE 1-4B
VOLTAGE NULLING OF RESIDUAL FIELD SENSOR OUTPUT

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

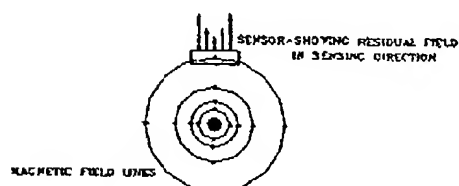


FIGURE 1-5A
TRANSMITTER COIL CROSS SECTION FOR SINGLE WIRE COIL
SHOWING SENSOR POSITION AND RESIDUAL FIELD

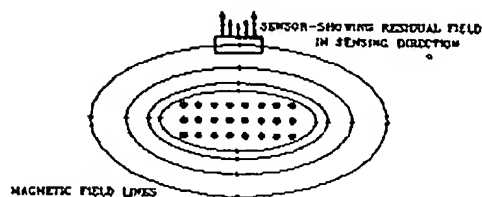


FIGURE 1-5B
TRANSMITTER COIL CROSS SECTION FOR NORMAL RECTANGULAR COIL
SHOWING SENSOR POSITION AND RESIDUAL FIELD

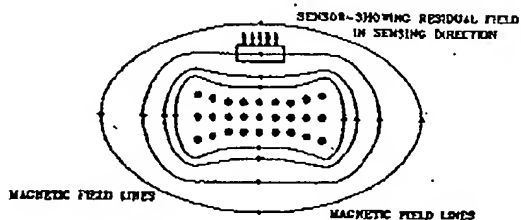


FIGURE 1-5C
TRANSMITTER COIL CROSS SECTION FOR SHAPED COIL
SHOWING SENSOR POSITION AND RESIDUAL FIELD

U.S. Patent Application Serial No. 10/821,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14038/299978
REPLACEMENT DRAWING

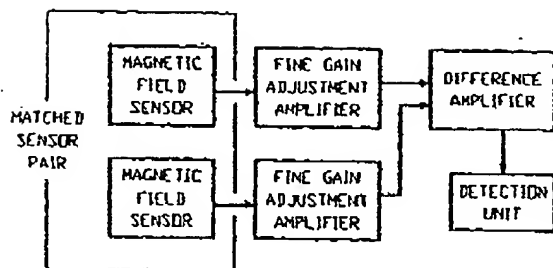


FIGURE 1-6
GRADIENT SENSING USING A MATCHED SENSOR PAIR

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence,
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

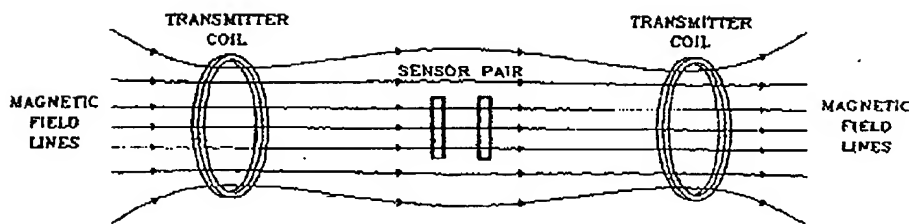


FIGURE 1-7
SENSOR PAIR CALIBRATION
USING TWO TRANSMITTER EQUAL COILS

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

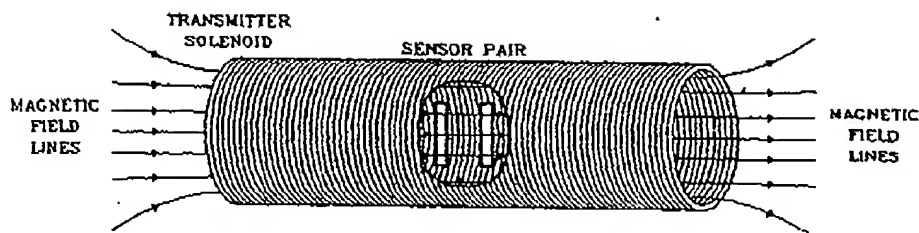


FIGURE 1-8
SENSOR PAIR CALIBRATION
USING A LARGE SOLENOID COIL

U.S. Patent Application Serial No. 10/827,089
 Filed: April 19, 2004, Inventor: James Wagner Larsen
 For: Systems and Methods Useful For Detecting Presence
 And/Or Location Of Various Materials
 Attorney: James L. Ewing, IV, Telephone: 404.815.6494
 Attorney Docket No. 14088/299978
 REPLACEMENT DRAWING

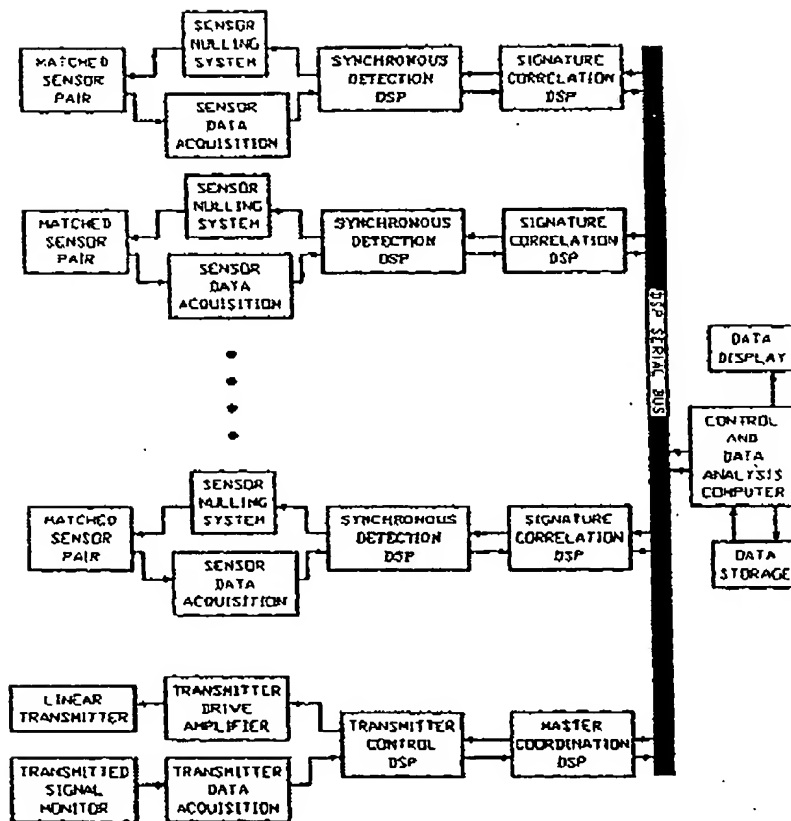


FIGURE 1-9
 SYSTEM WITH MULTIPLE SENSOR PAIRS
 AND SYNCHRONOUS DETECTION
 BASED ON DSP PROCESSORS

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14083/299978
REPLACEMENT DRAWING

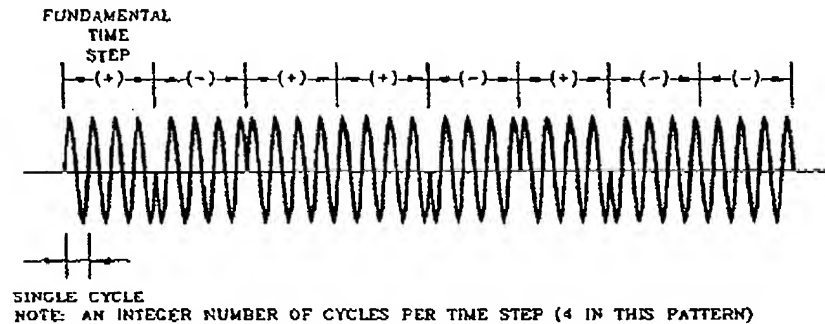


FIGURE 1-10
AN 8 SECTION (+ - + + - + - -)
TIME ENCODED WAVEFORM

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence,
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

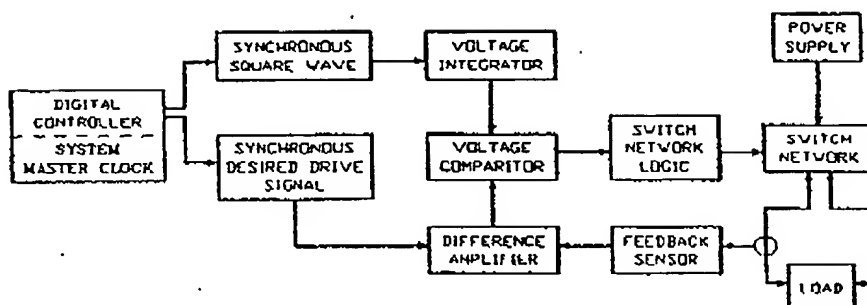


FIGURE 2-1
SYNCHRONOUS PULSE WIDTH MODULATION AMPLIFIER

U.S. Patent Application Serial No. 10/827,089
 Filed: April 19, 2004, Inventor: James Wagner Larsen
 For: Systems and Methods Useful For Detecting Presence
 And/Or Location Of Various Materials
 Attorney: James L. Ewing, IV, Telephone: 404.815.6494
 Attorney Docket No. 14088/299978
 REPLACEMENT DRAWING

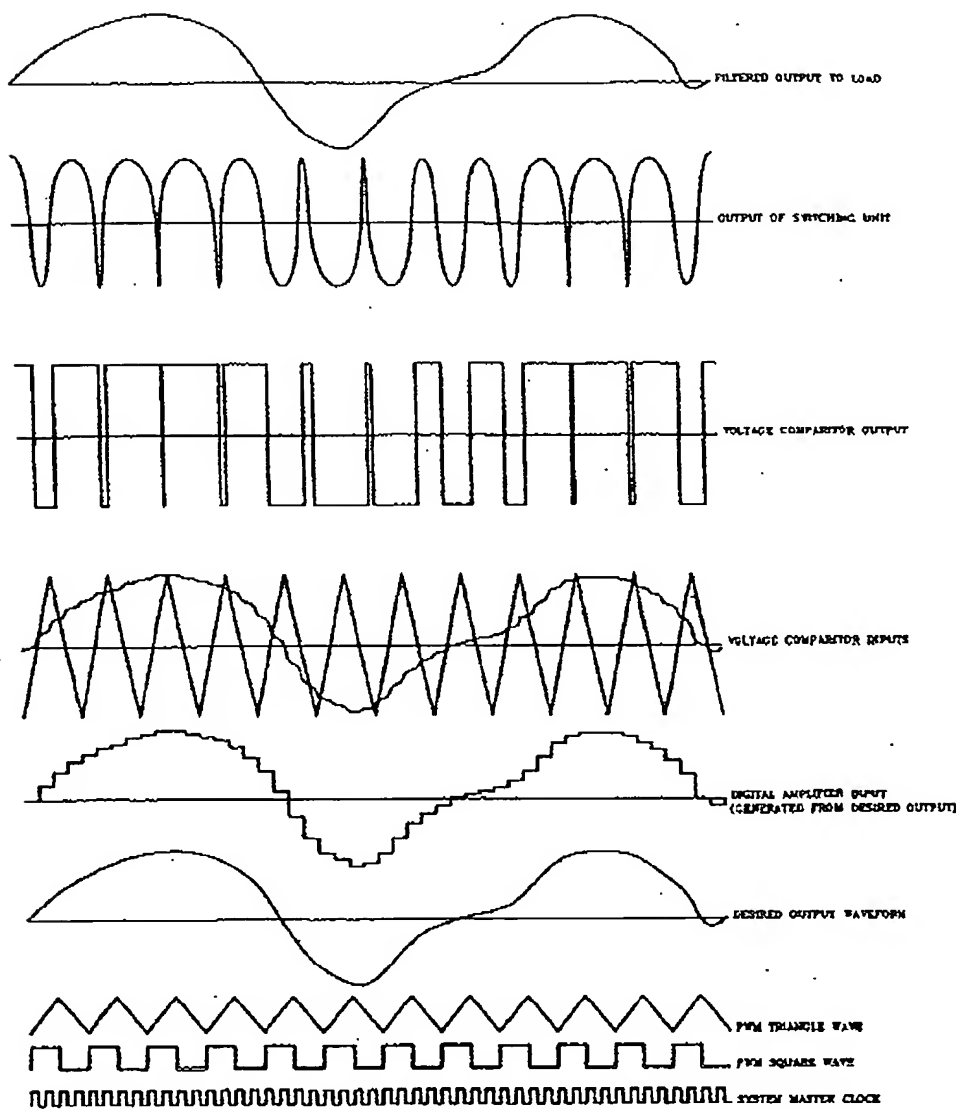


FIGURE 2-2
 TYPICAL PULSE WIDTH MODULATION WAVEFORMS

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14083/299973
REPLACEMENT DRAWING

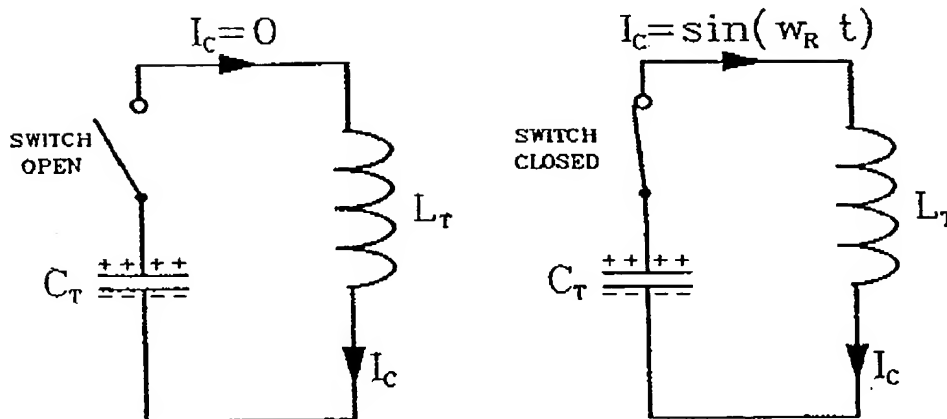


FIGURE 4-1
WHEN SWITCH IS CLOSED CIRCUIT OSCILLATES
AT RESONANT FREQUENCY, ω_R

U.S. Patent Application Serial No. 10/327,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

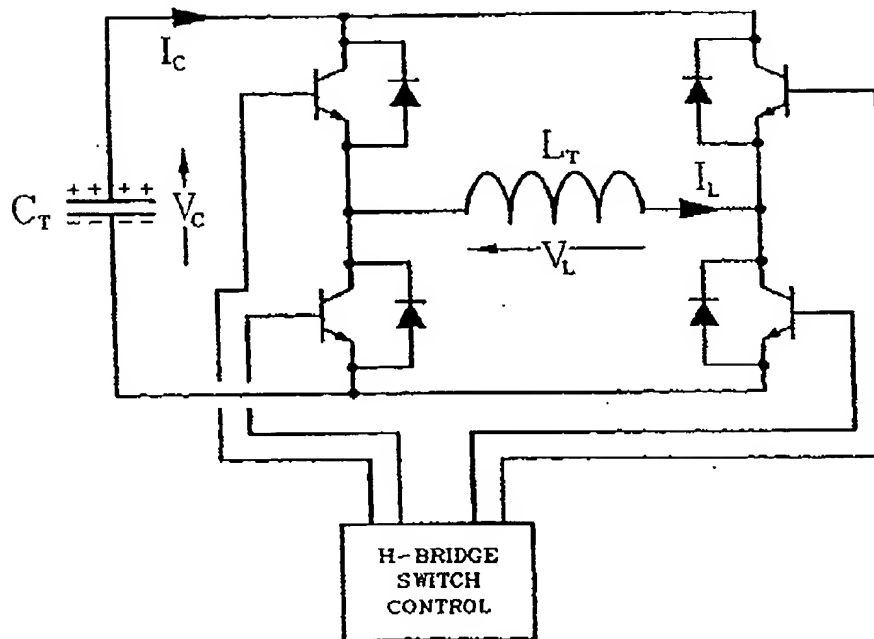


FIGURE 4-2
AN H-BRIDGE SWITCH NETWORK
CONNECTING THE CHARGED CAPACITOR
TO THE LOAD COIL

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

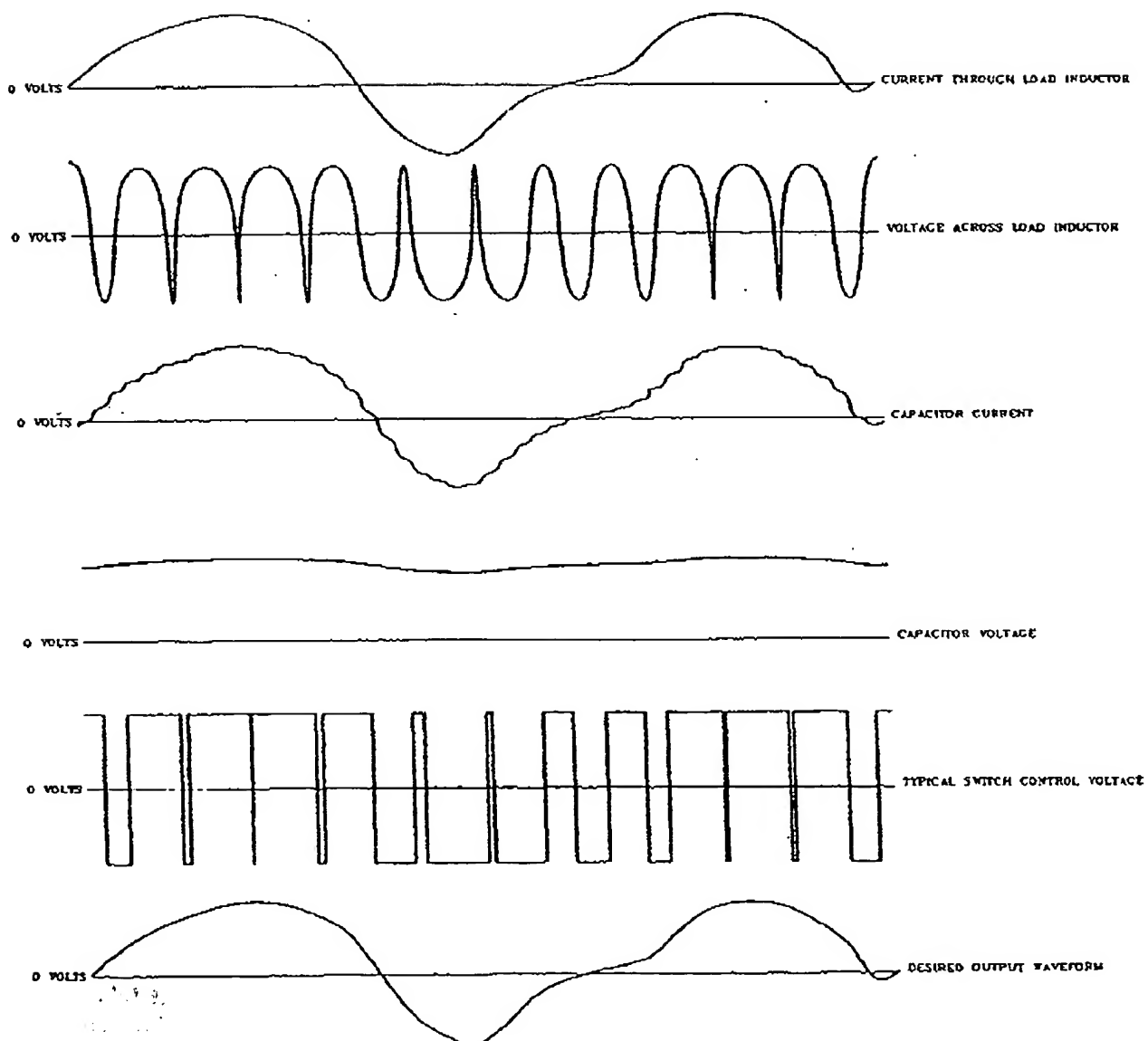


FIGURE 4-3
SWITCHED CAPACITOR CIRCUIT WAVEFORMS

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

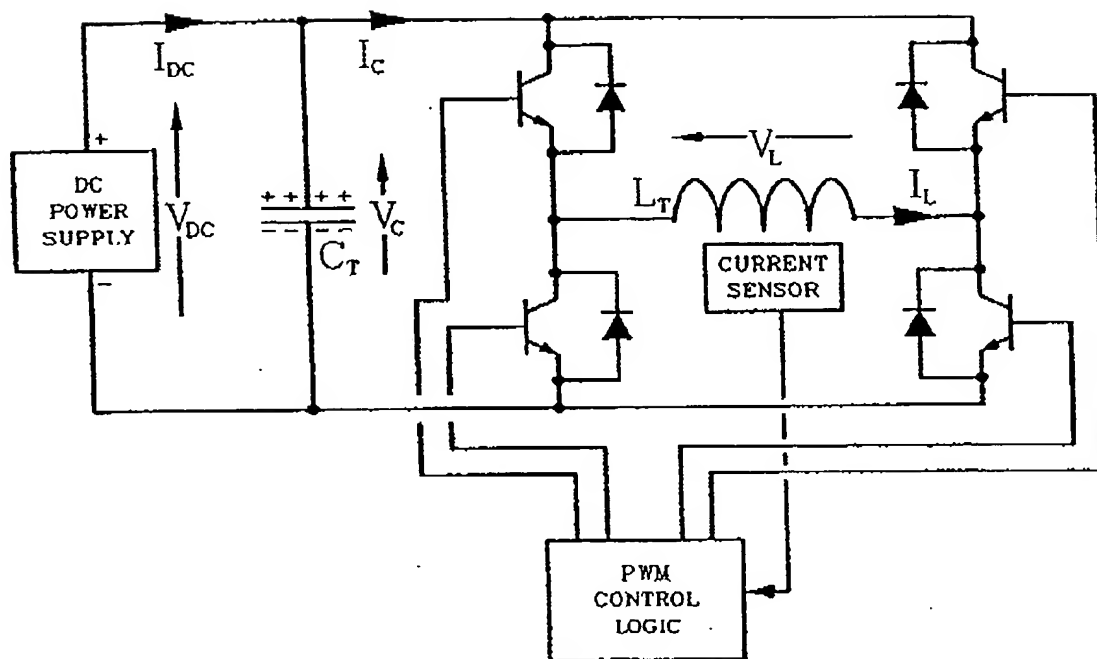


FIGURE 4-4
PULSE WIDTH MODULATED
SWITCHED CAPACITOR RESONATOR

U.S. Patent Application Serial No. 10/827,089
 Filed: April 19, 2004, Inventor: James Wagner Larsen
 For: Systems and Methods Useful For Detecting Presence
 And/Or Location Of Various Materials
 Attorney: James L. Ewing, IV, Telephone: 404.815.6494
 Attorney Docket No. 14088/299978
 REPLACEMENT DRAWING

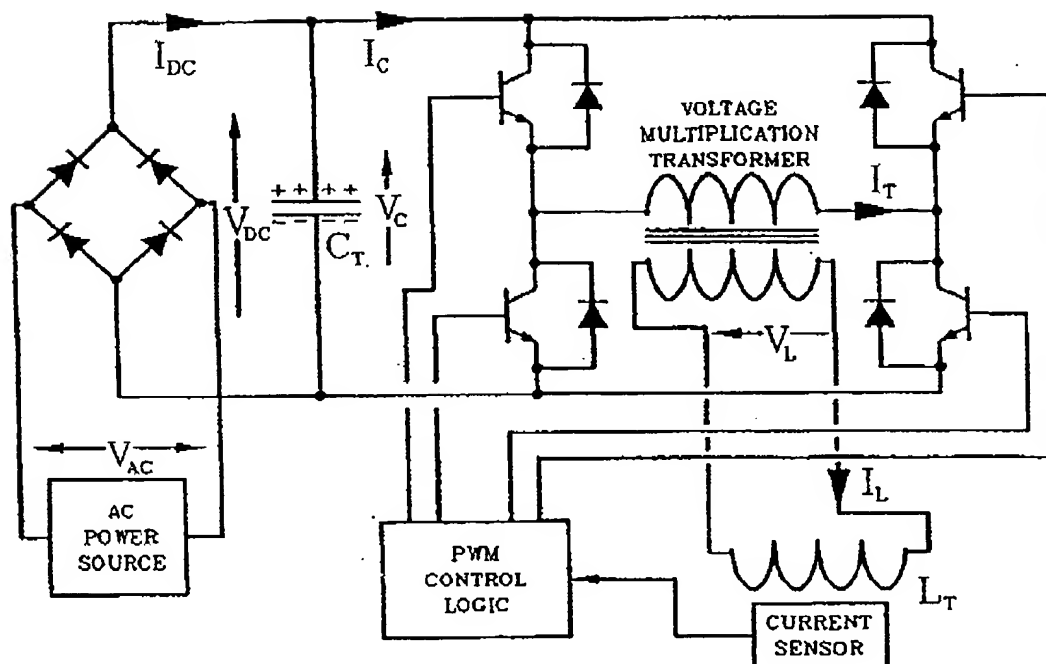


FIGURE 4-5
 SWITCHED CAPACITOR RESONATOR
 WITH INTEGRAL SWITCHING POWER SUPPLY

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

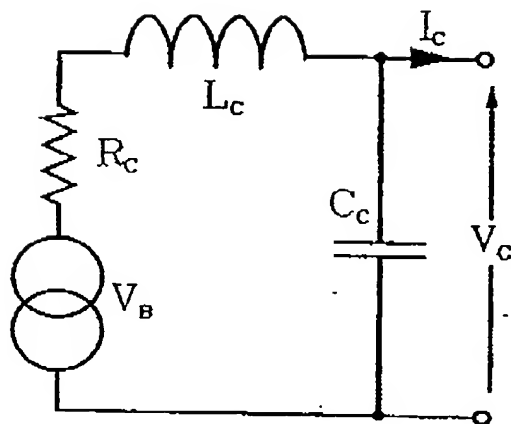


FIGURE 5-1
SENSE COIL EQUIVALENT CIRCUIT

U.S. Patent Application Serial No. 10/827,089
 Filed: April 19, 2004, Inventor: James Wagner Larsen
 For: Systems and Methods Useful For Detecting Presence
 And/Or Location Of Various Materials
 Attorney: James L. Ewing, IV, Telephone: 404.815.6494
 Attorney Docket No. 14088/299978
 REPLACEMENT DRAWING

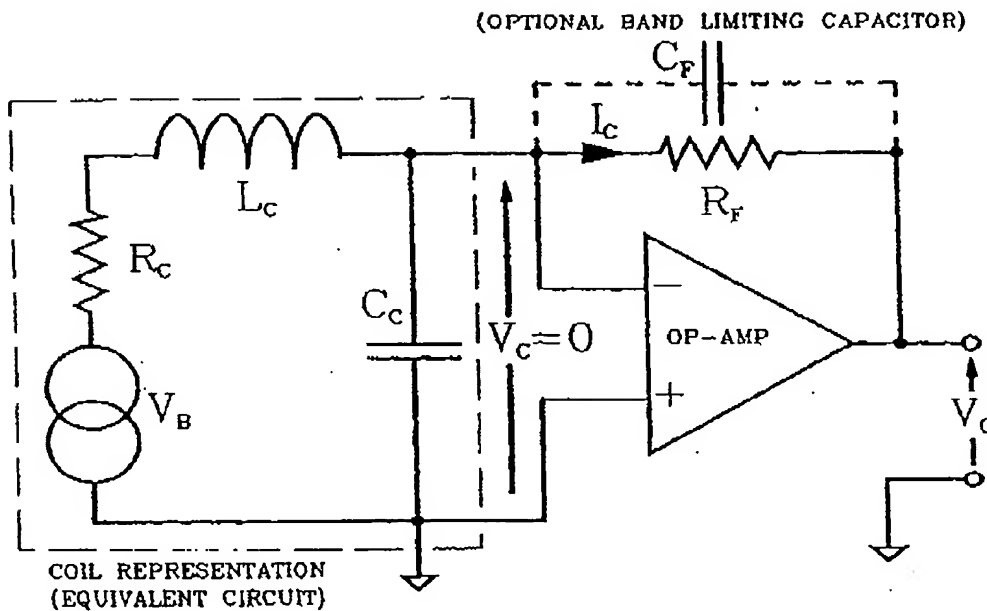


FIGURE 5-2

OPERATIONAL AMPLIFIER BASED VOLTAGE TO CURRENT CONVERSION CIRCUIT

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14038/299978
REPLACEMENT DRAWING

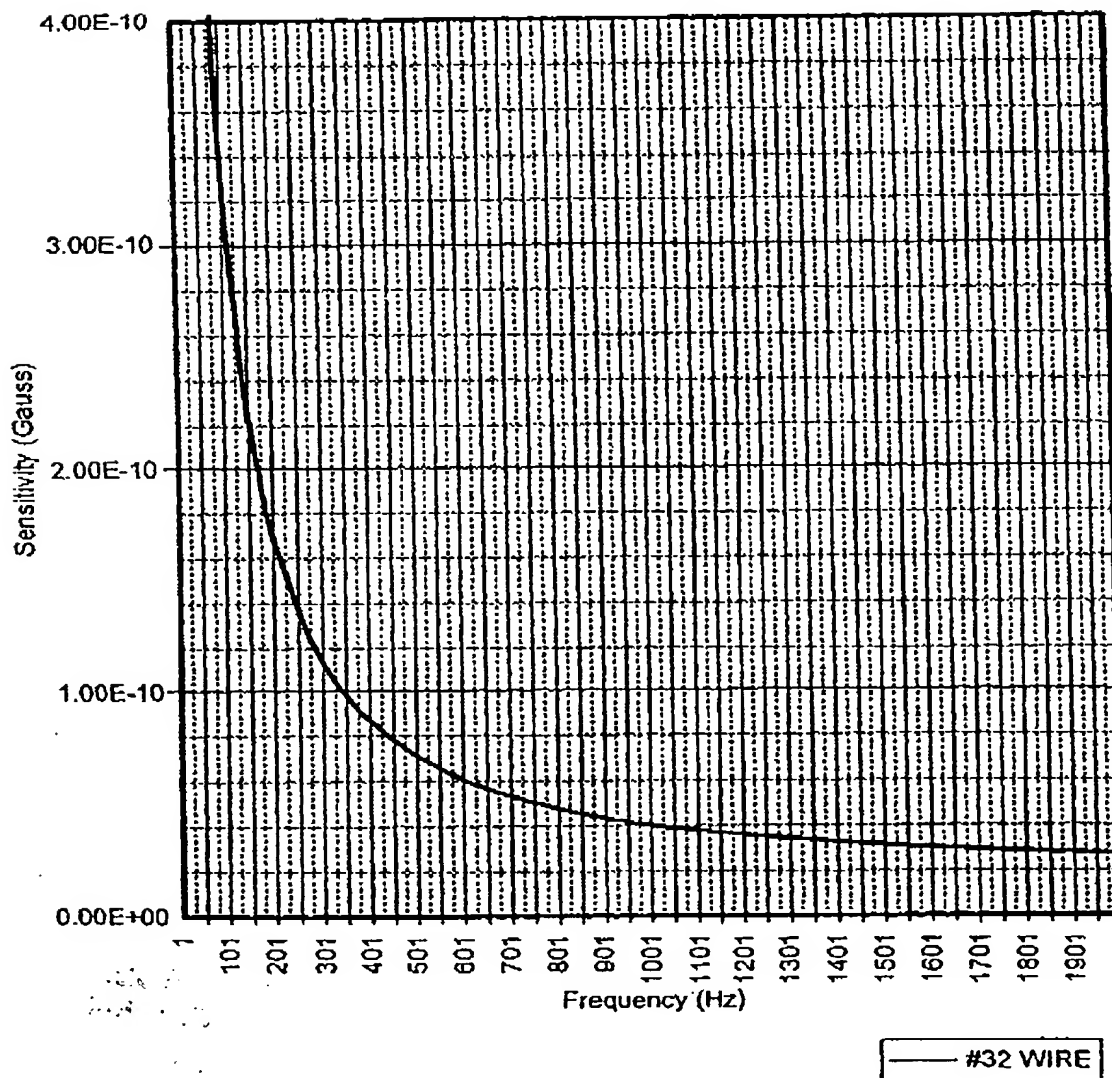
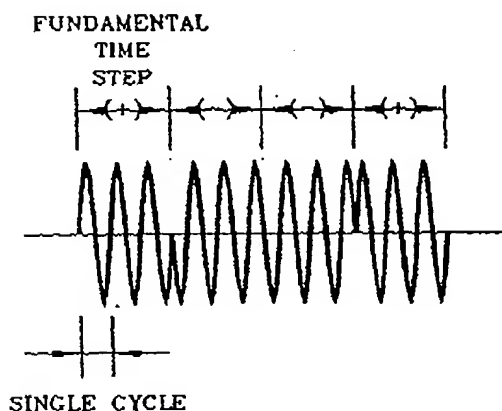
SENSITIVITY FOR #32 WIRE WITH $R_f + 10M\Omega$ 

FIGURE 5-3

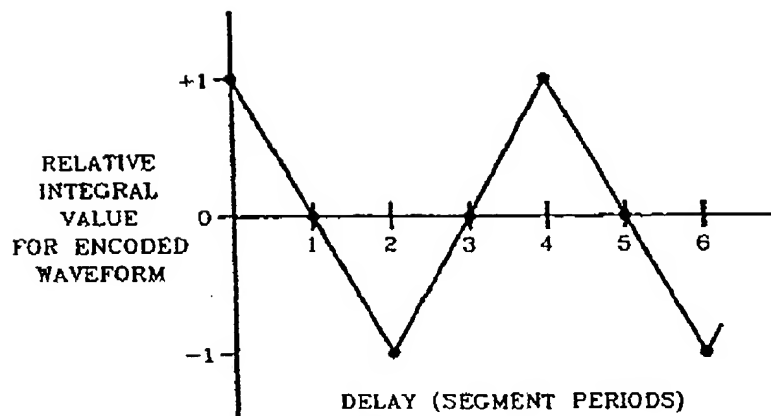
U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence,
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING



NOTE: AN INTEGER NUMBER OF CYCLES PER TIME STEP
(3 IN THIS PATTERN)

FIGURE 6-1
A 4 SEGMENT (+ - - +)
TIME ENCODED WAVEFORM

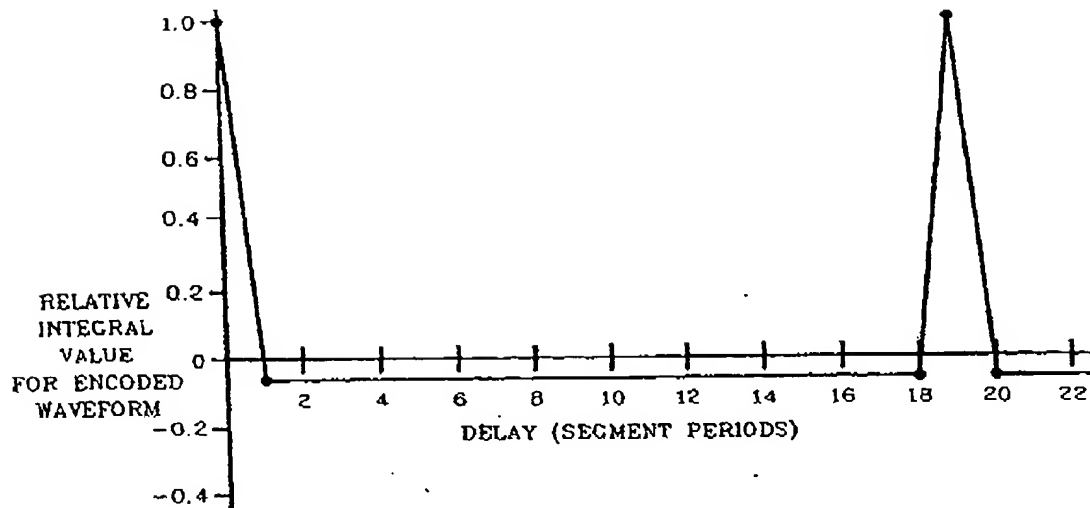
U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.513.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING



NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS ZERO

FIGURE 6-2
CORRELATION OF THE 4 SEGMENT (+ - - +)
ENCODED WAVEFORM WITH ITSELF

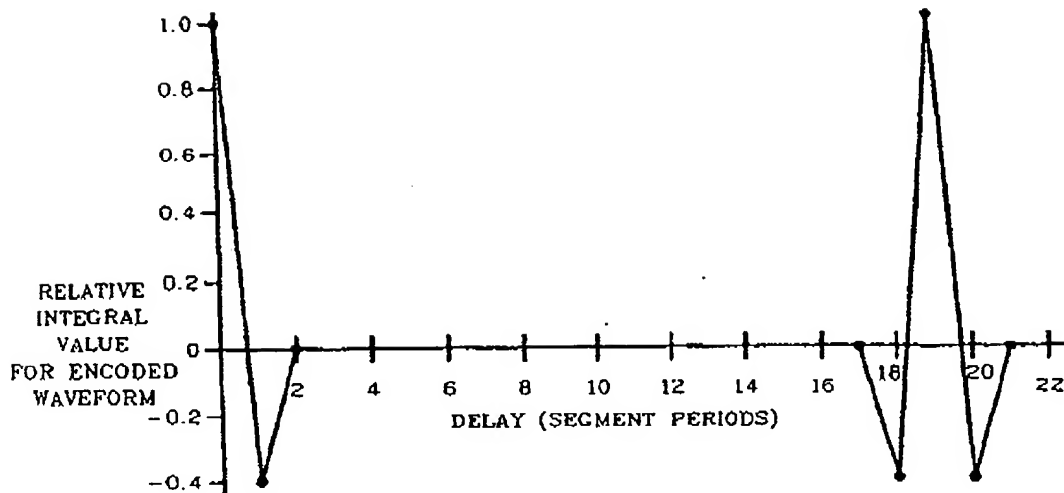
U.S. Patent Application Serial No. 10/827,089
 Filed: April 19, 2004, Inventor: James Wagner Larsen
 For: Systems and Methods Useful For Detecting Presence
 And/Or Location Of Various Materials
 Attorney: James L. Ewing, IV, Telephone: 404.815.6494
 Attorney Docket No. 14088/299978
 REPLACEMENT DRAWING



NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS 0.0526

FIGURE 6-3
 CORRELATION OF THE 19 SEGMENT
 (++++--++--++--++--++--++--++--++--)
 ENCODED WAVEFORM WITH ITSELF

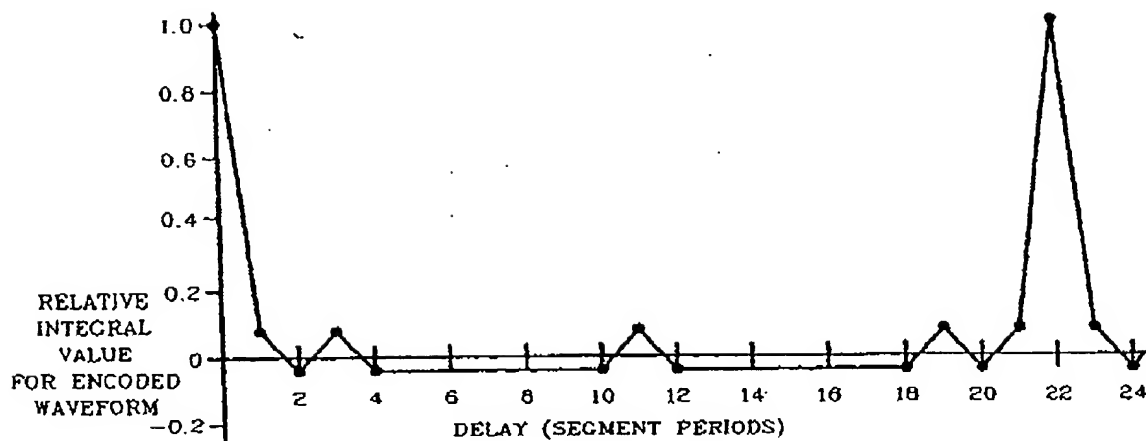
U.S. Patent Application Serial No. 10/627,089
 Filed: April 19, 2004, Inventor: James Wagner Larsen
 For: Systems and Methods Useful For Detecting Presence
 And/Or Location Of Various Materials
 Attorney: James L. Ewing, IV, Telephone: 404.815.6494
 Attorney Docket No. 14088/299978
 REPLACEMENT DRAWING



NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS -0.1

FIGURE 6-4
 CORRELATION OF THE 20 SEGMENT
 (+ - - - + + - - + - - + - + + - + - + -)
 ENCODED WAVEFORM WITH ITSELF

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence:
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING



NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS ZERO

FIGURE 6-5
CORRELATION OF THE 22 SEGMENT
(++++-----+--+--+---++)
ENCODED WAVEFORM WITH ITSELF

U.S. Patent Application Serial No. 10/527,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14058/299978
REPLACEMENT DRAWING

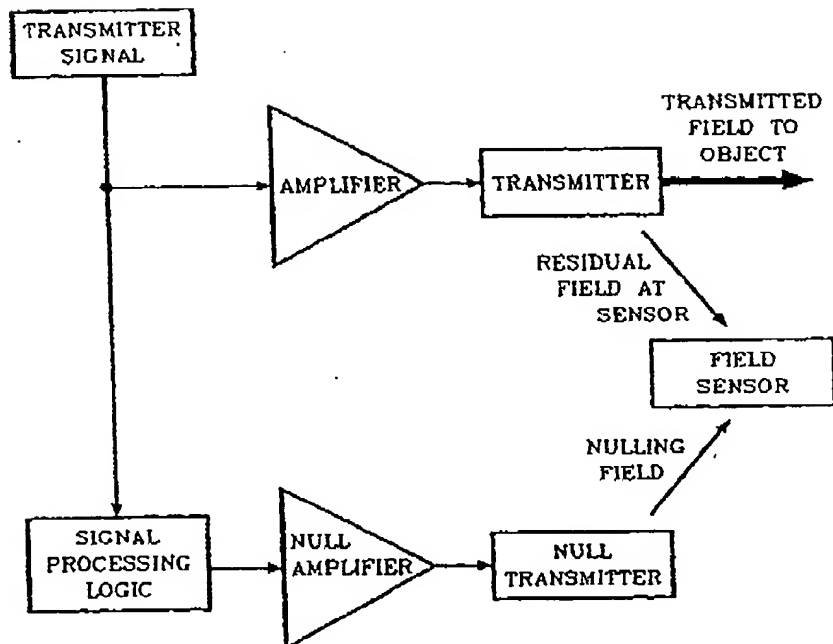


FIGURE 7-1
LOCAL MAGNETIC FIELD GENERATION
FOR RESIDUAL FIELD CANCELLATION

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

☐ BLACK BORDERS

☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES

☐ FADED TEXT OR DRAWING

☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING

☐ SKEWED/SLANTED IMAGES

☒ COLOR OR BLACK AND WHITE PHOTOGRAPHS

☐ GRAY SCALE DOCUMENTS

☐ LINES OR MARKS ON ORIGINAL DOCUMENT

☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY

☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.